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RECOMMENDED MILKING PRACTICES

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In the past much emphasis has been put on milk production. Dairymen have been given information concerning all phases of production including feeding, breeding, record keeping and how to grow more feedstuffs on available land. Much less emphasis has been given to the harvesting of the milk crop. No farmer would cut his hay crop with every fifth cutter missing from his mowing machine nor would he use a corn picker to harvest his corn crop with every fifth stalk untouched. In these examples, the loss of the crop unharvested would be obvious and could be immediately corrected. Many dairymen, however, leave a considerable portion of their milk crop unharvested, and since the loss is not so obvious, nothing seems to be done about it. In an attempt to help the dairyman to do a better job of harvesting his milk crop, this bulletin lists some of the do's and don'ts which apply to the milking procedure.

Internal Structure of the Udder

The general internal structure of the udder is shown in figure 1. The general supporting tissues are outlined, showing how the udder is suspended from the cow and how the secretory tissue is suspended within the udder itself. The teat cistern and udder cisterns can be seen. The milk collects in these cisterns at the time of milking before it is drawn from the udder. Within each quarter there is a structure similar to that of a bunch of grapes. The stems on the bunch of grapes would represent ducts or tubes, which connect the secretory cells to the cisterns at the lower part of the udder. The grapes themselves, then, would be equivalent to the portion of the udder which actually secretes the

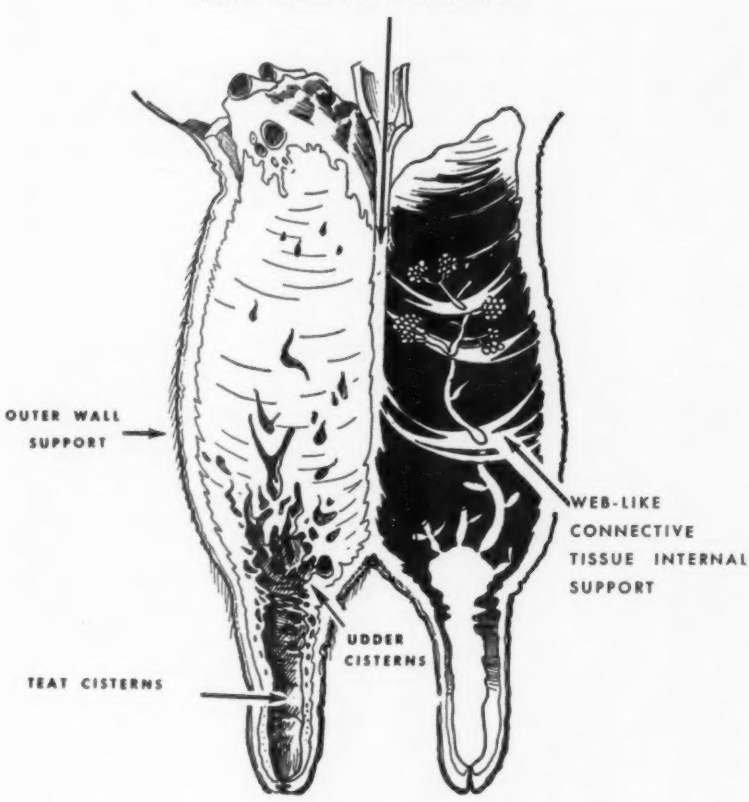


Figure 1. An udder cross-sectioned through both rear teats shows how Nature fastened the udder to the cow and how the various parts are supported within the quarters. The left half is sketched (from Zietzschmann) the way the udder looks held up in the middle by the elastic suspensory membrane and contained at bottom and sides by an outer skin which fastens above to the abdominal walls of the cow.

The right half simply shows how one single duct with its secretory cells on the end is held in place by connective tissue which criss-crosses the interior of each quarter.

milk. The cells which actually produce the milk are grouped in spheres much like hollow balls which are called alveoli. As the milk is produced, it collects in the hollow center of this group of cells (figure 2). Figure 3 shows the milk secreting alveoli.

An udder of good quality will completely collapse after the milk is withdrawn because the bulk of the good quality udder is made up of secretory tissue with a small amount of fine connective tissue rather than a predominance of the latter. The expansion of the udder between milkings is due to the filling of the alveoli with milk.

Let Down of Milk

The production of milk in the cow's udder is a continuous process. As the milk is secreted or produced by the

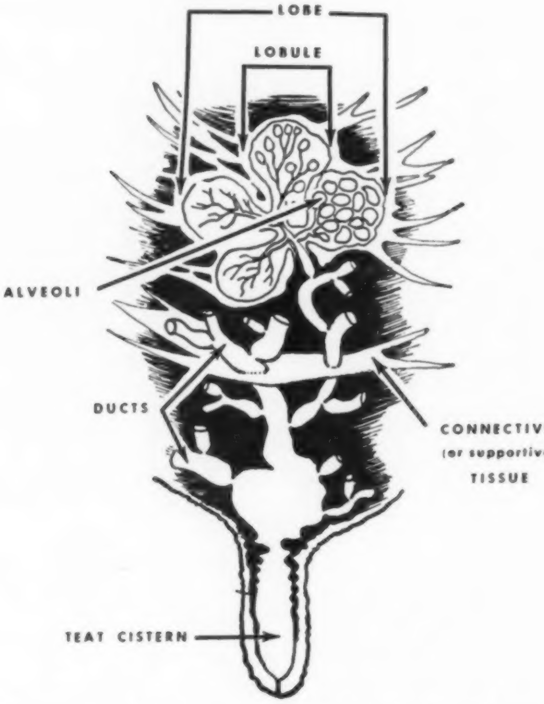


Figure 2. Each quarter consists of many Lobes, each of which contain smaller Lobules, which in turn contain many alveoli. The teat is connected to each of these millions of alveoli by a complicated duct system supported throughout by connective tissue.

cells of the alveoli it collects in the hollow interior of this group of cells. Almost all of the milk produced remains in the alveoli until the time of milking. Therefore, at the time of milking it is necessary to stimulate the cow so that the milk can be transferred from the alveoli to the cisterns and in turn be extracted by the machine. How does this occur?

Experiments have shown that let down of milk is due to a reflex act which involves a nervous stimulus, a hormone from the pituitary gland, the blood, and the smooth muscles in the mammary gland. The normal stimulation of milk let down is brought about by massaging the udder in preparation for milking. This stimulates the rich supply of nerves in the teats which send a message to the brain. Some cows condition themselves to other types of stimuli. They will let their milk down when fed or when they

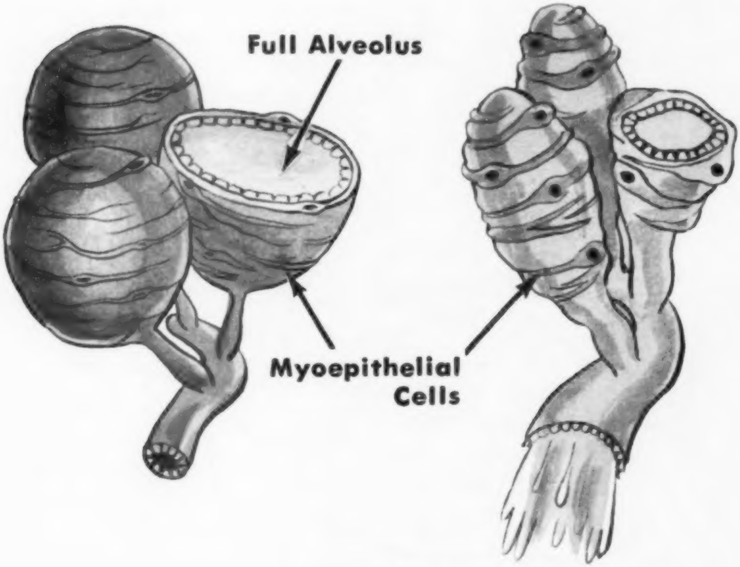


Figure 3. Stages of alveoli from full to empty. At left is a drawing of how several alveoli would look just before milking — full and round, with myoepithelial cells relaxed and extended. Even the duct is relaxed.

At right is how they would look after stimulation and during milking. The myoepithelial cells have shortened and squeezed each alveolus displacing much of the milk into the duct system and cisterns. Fast removal of the milk is necessary during this stage which lasts less than 10 minutes.

hear certain noises associated with milking preparation. This message then causes the pituitary gland to secrete into the blood a hormone known as oxytocin which is carried by the circulating blood to the udder where the smooth muscle cells are activated. Figure 3 shows the alveoli surrounded by these myoepithelial or smooth muscle cells. When activated these cells contract and squeeze the milk from the alveoli. This squeezing action takes place in much the same manner as you would squeeze the air from a punctured hollow ball with your hand.

These smooth muscle cells surrounding the alveoli are activated about one minute following the stimulation for let down of milk. The effect of the oxytocin on these smooth muscles lasts, on the average, for about 7 minutes. In other words, for the greatest effect of milk let down on speed of milking, the milking machine should be attached not earlier than 1 minute but not later than 2 minutes following the stimulation of milk let down.

Holding Up the Milk

A cow does not willfully hold up her milk as you and I would decide to do or not to do something. However, when the cow is frightened or mistreated there is another hormone which interferes with normal let down of milk. Figure 4 shows diagrammatically what happens when a cow is fright-

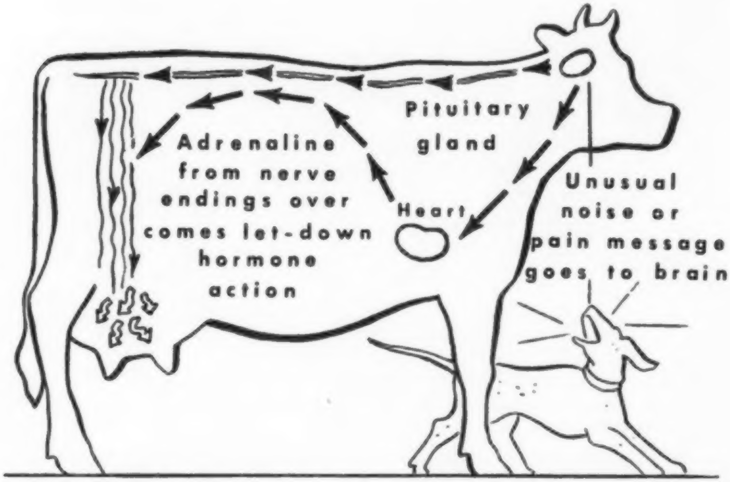


Figure 4. Excitement or pain causes adrenaline to overcome the action of the milk let-down hormone.

ened by a dog barking. Even though she has been stimulated for a normal let down of milk, the effect of the oxytocin is interferred with by the hormone adrenalin which comes from the nerve endings and the adrenal gland. As long as this hormone is present, the cow cannot let down her milk. Figure 5 shows the effect of fright, attaching milker too soon, and pain on the rate of milk flow in comparison to normal response of a cow handled correctly. In the case of the cow frightened before milk let down had occurred, the only milk obtained was that which had collected in the gland cisterns. Attaching the milker before milk let down has occurred may cause some irritation and prevent a full response from the oxytocin. This will probably vary from cow to cow. Pain caused by kicking or beating can interfere with the let-down mechanism and prevent complete milking out.

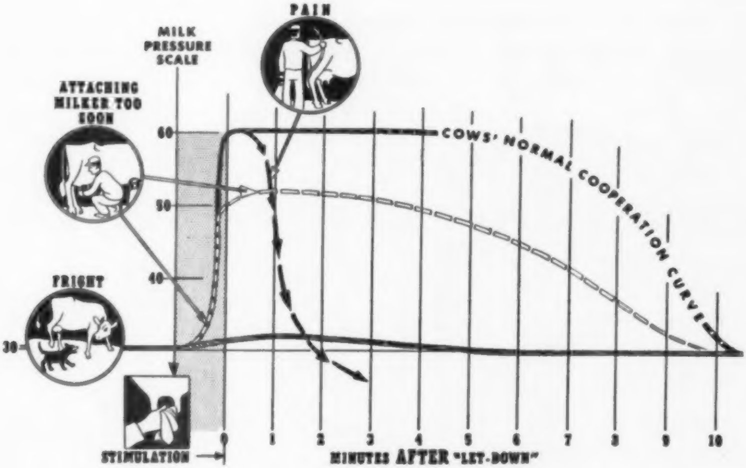


Figure 5. How the hold-up hormone interferes with the cow's cooperation. On a frightened cow, the adrenalin in her blood would literally prevent any let down action for a period up to 25 minutes. Irritation caused by putting on a machine before stimulation is completed dilutes the let-down hormone with adrenalin to prevent full cooperation. Pain after stimulation causes her udder pressure to drop quickly.

Any irritation or distraction during milking can release enough "Hold-up" hormone to counteract the "Letting Down" pressure — which in turn lessens the amount of milk you get at that milking.

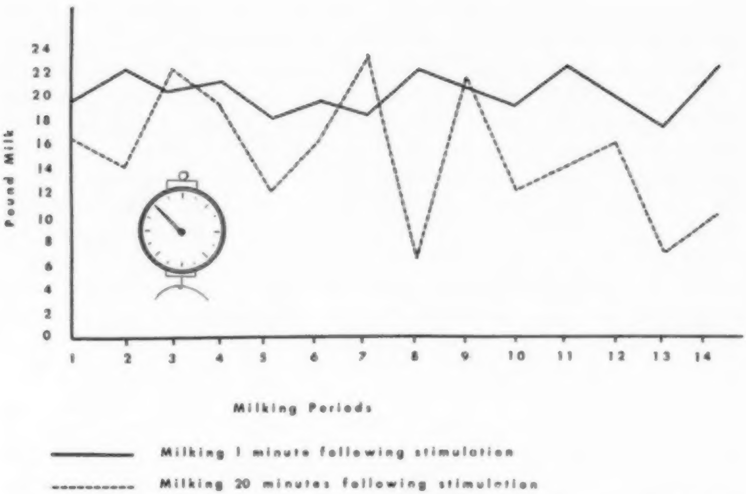


Figure 6. The effect of delay in milking following milk let down on total milk obtained per milking for 14 consecutive milkings.

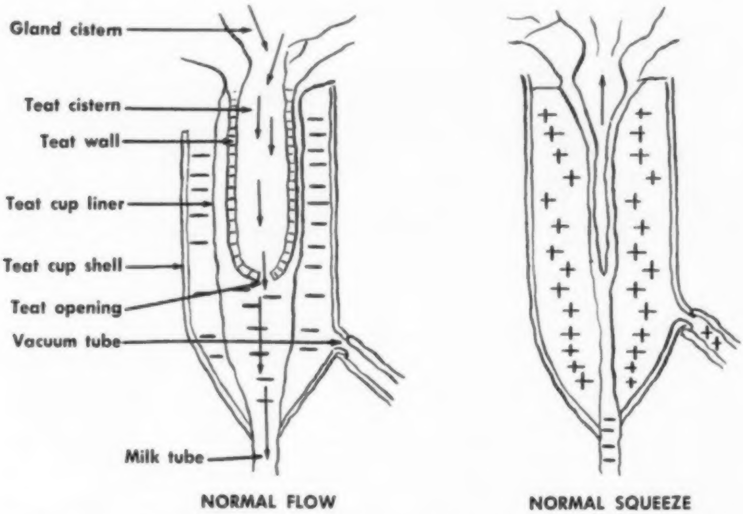


Figure 7. Alternating onset and release of vacuum between the teat cup shell and the liner cause the milk to flow.

Attaching the Milker

It has been demonstrated that forty-five seconds to one and one half minutes are required for the actual let down of milk to occur following the stimulus. The full effect of oxytocin lasts for about 7 minutes on the average. With this in mind the milking machine should be attached between 1 and 2 minutes following the stimulation for let down of milk in order to receive all of the help possible from the oxytocin hormone. Figure 6 shows the effect of delayed application of the milker in comparison with the normal application of the milker 1 minute following stimulation. The chart shows that irregular amounts of milk are obtained when the milking machine is not put on the cow until 20 minutes have elapsed following stimulation. This indicates that the cow is not completely milked out and that over the one week period less total milk was obtained from the delayed procedure.

The Operating Principle of a Milking Machine

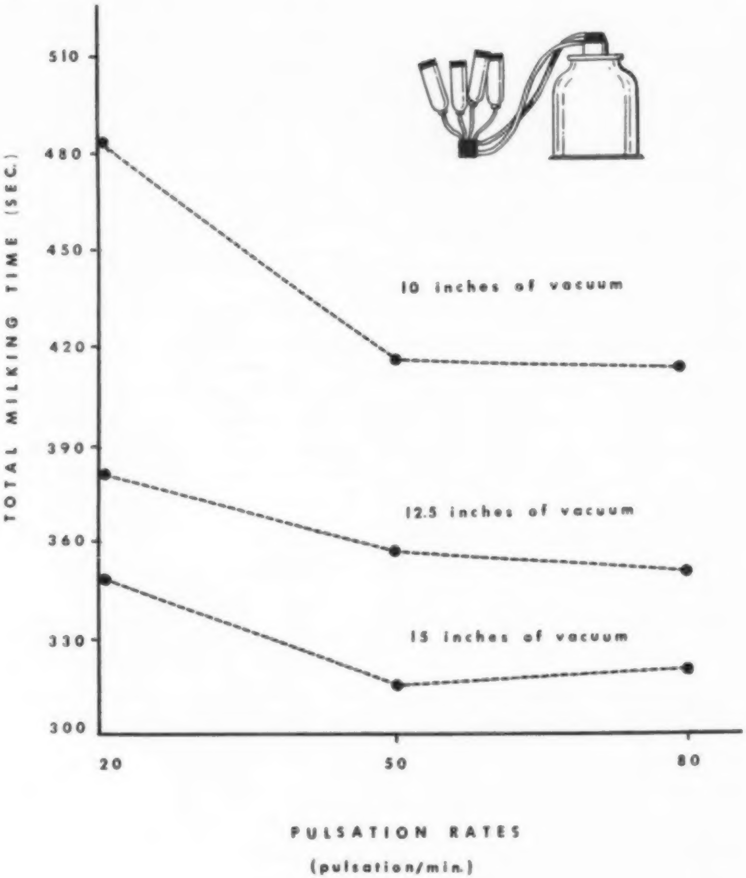
The functioning of a milking machine is not understood by many, even those who have operated them for years. Figure 7 will serve to show how the milk is drawn from the teat. A state of partial vacuum exists in the milker pail continuously. This vacuum is transmitted through the milk tube to the opening of the teat. What actually gives the pulsation to the milker is the alternate onset and release of vacuum between the teat cup shell and the inflation or teat cup liner. When there is no vacuum, the inflation collapses around the teat. This massages the teat and prevents congestion of blood in it. At the onset of vacuum between the teat cup shell and the inflation liner, the liner springs back to a normal position and vacuum from the milker pail causes the milk to flow from the teat. The minus signs in the diagrams indicate vacuum or negative pressure. Plus signs indicate a lack of vacuum.

Proper adjustment of the milking machine is important in obtaining all the milk following a response to the stimulus. Recent work at Cornell University dealing with the effects of vacuum level and pulsation rate on 18 slow milking cows is presented in figure 8.

Vacuum Level and Pulsation Rate

In general, the speed of milking can be affected by varying either the pulsation rate or the vacuum level. Figure 8 shows the effect of 3 different pulsation rates at 3 different vacuum levels on slow milking cows. In general the results can be summarized as follows: (1) Increasing the vacuum level increased the speed of milking. (2) Increasing the pulsation rate increased speed of milking but the magnitude of this effect was much less than that resulting from increasing the vacuum level. (3) Increasing pulsation rate appeared to be more important at low levels of vacuum than it did at high vacuum levels. (4) In-

Figure 8. The effect of different vacuum levels and pulsation rates on total milking time.



creasing the pulsation rate from 50 to 80 pulsations per minute had little effect at any vacuum level.

One should keep in mind that the best vacuum level and pulsation rate for any milker is that recommended by the manufacturer of the machine. The above experiment points out, especially, the effect of vacuum levels and pulsation rates below those recommended by the manufacturer of the machine.

Milking Time

The question arises, just how long should it take to milk a cow? The results of an experiment in which 232 cows were timed in the Cornell herd can be seen in table 1. These cows were all in mid-lactation at the time of the experiment. The cows vary from less than 3 minutes to more than 5 minutes, with 74 percent of the cows milking out in less than 4 minutes. The average for all cows in the experiment was 3 minutes and 37 seconds.

The primary cause of variation in milking time between cows in the same stage of lactation is the strength of the muscle surrounding the teat opening. The stronger the muscle the slower the cow will milk. Other factors may affect the speed of milking, but at present are not well understood.

Table 1. Variation in Total Milking Time

(232 Cows in Mid-lactation)

Under 3 minutes	36%
3 - 4 minutes	38%
4 - 5 minutes	17%
Over 5 minutes	9%

The amount of time required for milking the same cow will vary with the stage of lactation. Table 2 shows an experiment with 98 cows giving the milking time and the rate of milk flow for three stages of the lactation. It will be noticed that the total time is greater for the early part of the lactation, but this is due to more total milk being produced. The rate of milk flow is greatest during the early part of the lactation and slowest at the end of the lactation.

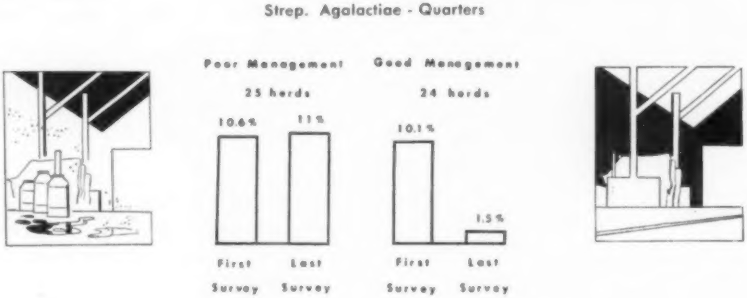
Table 2. Variation in Rate of Milking as Affected by Stage of Lactation and Breed

Group Stage of Lactation	No. Cows	Machine Time Milking	Machine Time Stripping	Total Time	Total Milk	Rate of Milking
		Min. & sec.	Min & sec.	Min. & sec.	lbs.	lbs./min.
Early—48 days in milk	98	3:56	0:32	4:28	18.9	4.4
Middle—154 days in milk	98	2:53	0:32	3:25	13.2	4.0
Late—255 days in milk	98	2:09	0:40	2:49	8.4	3.0

Controlling Mastitis

During the past few years there has been an indiscriminate use of antibiotics on the part of the dairymen in an attempt to control mastitis. However, the mastitis control program, which is under the supervision of the New York State Veterinary College,

Figure 9. The effect of good management versus poor management in controlling infectious mastitis.



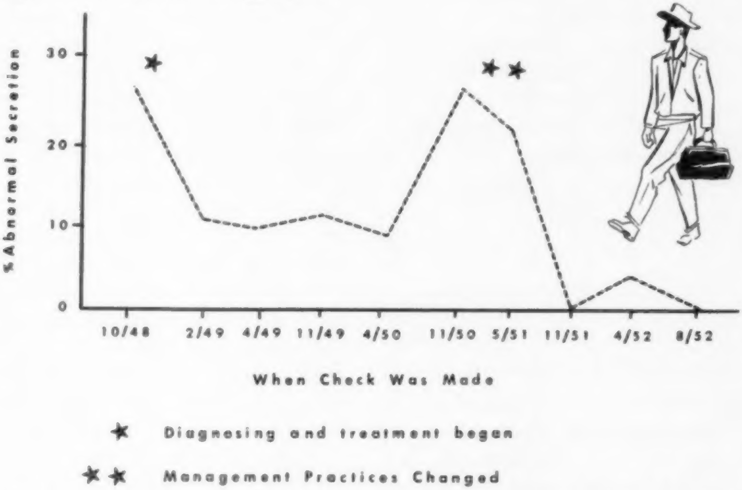
has shown that the use of antibiotics alone is not completely effective in controlling mastitis. They have shown that it is necessary to incorporate good management practices along with good veterinary service for diagnosing and treatment. Figure 9 shows the effect of herd management on mastitis control in two groups of herds. Both herds had about the same veterinary service. The primary difference between the herds was one of management. As can be seen, the per cent of the quarters infected at the last survey was about the same as the degree of infection at the first survey. The herds with good management dropped from 10.1 percent infected quarters to 1.5 percent infected quarters between the first and last survey.

Figure 10 shows a single herd that called in a veterinarian for a consultation and diagnosis in late 1948. The infected cows were treated, and as can be seen, the percentage of abnormal milk dropped from about 25 percent to 10 percent during the first four months following the beginning of the treatment. However, the treatment did not completely clear up the abnormal secretions. The management practices in this herd remained about the same until January 1951. At this time the milking machines were checked for vacuum and pulsation rate, the vacuum lines were cleaned, and the management practices in regard to milking were completely changed. The treatment was continued as before, and as can be seen, the percentage of cows showing abnormal secretions dropped to zero and, following the period of August 1952, remained low. This again points out the necessity of good management along with good veterinary treatment in controlling mastitis.

Some of the management practices which can be used to help control mastitis are listed below.

1. Adjust the milking machine for proper vacuum level and pulsation rate.
2. Stimulate milk let down and do not attach the machine to the cow until let down has occurred.

Figure 10. The effect of good management practices in addition to veterinarian diagnosing and treatment in controlling mastitis.



3. Use a strip cup to help identify early cases of abnormal secretion.
4. Remove the milking machine as soon as the cow is milked dry.
5. Organize a milking routine so that first calf heifers are milked early in the string and cows that have had infections of mastitis are milked last.
6. Dip teat ends in a mild antiseptic solution following the removal of the milking machine. Chlorine, iodine preparations or pine oil solution can be used.
7. Don't try to operate too many units; two per man are plenty when used in a stanchion barn.
8. Don't milk on the floor.
9. Provide adequate sized stall-beds so that cows can get up and down without injuring themselves.
10. Provide enough good straw bedding to keep cows dry and clean.
11. Remove bedding and caked manure periodically and disinfect the platform; a hot lye solution is satisfactory.
12. Be sure barnyards are properly graded and free from mud holes.
13. Allow for adequate dry periods. Sixty days dry are recommended as beneficial to udder health.

Proper Milking Procedure

For best results, the cow should be milked regularly, gently, thoroughly and promptly, with proper attention to sanitation. The following steps are practical and give good results.

1. Prepare cow for milking by cleaning and massaging the udder for about one-half minute.

(a) Stimulates let down of milk which is necessary for complete milking.

(b) Use of individual towels wrung out of warm water containing some type of sanitizer such as chlorine or iodine is recommended.

2. Milk out a few streams from each quarter in a strip cup.

   (a) Aids in early detection of mastitis.

   (b) Helps to stimulate let down.

   (c) Draws out first milk with high bacterial count.

3. Attach the teat cups about a minute or two after stimulation.

   (a) A cow usually lets down her milk about a minute after she has been prepared.

   (b) The effectiveness of the letdown gradually decreases with increased time.

4. Machine strip for about one-half minute when milk flow almost stops, as indicated by the appearance and feel of the udder.

   (a) Machine stripping consists of pulling down on teat cups with one hand and massaging the udder downward with the other. Give special attention to those quarters which do not milk out as readily as the others.

   (b) There will be considerable variation between cows in time required.

   (c) The amount of milk obtained by machine stripping will also vary but will average about 1½ to 2 pounds.

   (d) Hand stripping is not recommended except as necessary for an occasional problem cow.

5. Remove unit as soon as cow is milked dry.

   (a) Recognizing when a cow is milked dry is an art acquired through experience and knowledge of the individual cows.

   (b) The length of time the machine is left on each cow will vary considerably depending primarily upon the structure of the udder and the amount of milk produced, but most cows should milk out in less than four minutes.

Guides for Better Milking

In addition to following a good milking procedure, there are other important rules which must be followed in order to obtain the best results.

1. Do not excite cows at milking time.

   (a) Excitement causes an interference with milk let down and results in incomplete milking.

2. Keep machine and inflations in good working order.

   (a) Replace worn out rubber parts promptly.

   (b) Keep a close check on the vacuum. Repair or replace the vacuum pump, vacuum control valves and stall cocks when necessary.

   (c) Clean the vacuum line with a hot lye solution (one 13-ounce

can in 5 gallons of water) every one to 3 months.

(d) Keep pulsators clean and working properly.

3. Operate the machine according to manufacturer's directions.

(a) Increasing the vacuum above that recommended may tend to cause congestion and injury to the teat and reducing it may cause slow milking and difficulty in keeping the machine on the cow.

(b) Decreasing the pulsation rate below that recommended may cause teat congestion and injury. Increasing it above recommendation may wear out liners more rapidly and cause more difficulty in maintaining proper vacuum.

4. Organize the milking routine.

(a) Routines will vary according to the individual set-up.

(b) Operations should be so organized that a machine is available about 1 to 2 minutes after a cow has been washed and the operator is available to machine strip when a cow is ready.

(c) Two single units per man is the maximum that can be handled efficiently in a stanchion barn.

(d) It is better to have a machine sitting idle than to have it working on a cow after milk flow has stopped.

5. Milk cows as rapidly as possible.

(a) If a fast milking procedure has not been followed, it will be necessary to train cows to a fast milking program. The best way is to start the heifers off on a fast milking program. Older cows can be trained more easily at the beginning of the lactation period.

(b) Apparently there are a few cows that will be slow milkers regardless of how we handle them. Milk these problem cows toward the end of the line.

(c) Timing of the milking operation is a good way of checking the efficiency. An average of 4 minutes or less, actual machine time on the cow, represents an efficient operation. There is, however, considerable variation between cows. Most cows should take less than 4 minutes. Some may take more.

6. Use the proper milking order.

(a) Milk heifers first.

(b) "Leakers" and cows that "let-down" their milk before being washed should be milked early in the milking order.

(c) The regular milking routine will not be upset by slow milkers if they are milked after those that milk out in regular time.

(d) Cows that show any sign of udder infection should be milked after the clean cows.

7. Use proper sanitation at milking time.

(a) If cloth towels are used, use only towels that have been washed and sterilized.

(b) Disinfect teat cups between cows by rinsing first in clean, lukewarm water, then in a fresh, warm sanitizing solution of chlorine or iodine preparation.

(c) Dipping the teats in a mild antiseptic solution (chlorine or iodine preparation or pine oil) immediately after milking is helpful in controlling mastitis.

(d) Keep hands clean.

8. Equipment cleaning.

(a) Rinse the milker in cool or lukewarm water immediately after use.

(b) Wash the milker thoroughly with hot water and a good washing powder.

(c) Rinse and sterilize the milker after washing.

(d) Store the teat cup assembly on a lye solution rack (one tablespoon of lye per gallon of water). When really hot water (190°F.) is used for the final sterilization, the assembly can be stored dry.

(e) Rinse thoroughly with water and then good sterilizing solution before the next milking.

(f) The required frequency of complete disassembly depends upon the thoroughness with which the machine is washed day by day.

(g) Boil rubber inflations once a week for 15 minutes in a lye solution (3 tablespoons of lye per gallon of water) in an agateware container to keep them clean and prolong their life and efficiency. Have two sets of inflations and use them in alternate weeks to facilitate this procedure.

(h) Proper cleaning of equipment is doubly important in herds where mastitis is a problem.

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